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# The Non-violent Scientific Study of Birds

BY

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I am very ignorant about birds, largely because I am unmusical and most British birds are small and inconspicuous, so that their songs and call-notes are more distinctive than their colours or shapes.

In the nineteenth century it was hard to study birds without killing them. The first job of an ornithologist is to identify species; and in order to be sure that we have, for example, three and only three species of kingfisher in the suburbs of Calcutta it is necessary to kill a number, and find that all can be assigned to one of these species. This phase is now fortunately nearly over. One can learn to assign a bird to its correct species without killing it.

What is the next step? It is, I think, to find the distribution of species and subspecies in India at different times of the year, and also their local habitats, names, and so on. Here Ogniev's great Zoology of the U.S.S.R. could be a model. Ultimately we should look forward to a time when there will be an ornithologist for every hundred or so square miles of India capable of enumerating the local species, and a central organization such as the Bombay Natural History Society to make maps showing the distribution of each species in India. As, however, this would require ten thousand or so ornithologists it is not immediately possible. But a start can be made.

The next question to be asked is, perhaps, how many birds of one or more species there are in a given area. At first sight this is a very difficult question, as birds are so mobile. But as eggs they are extremely immobile. I hope that, if we develop statistical biology at the Indian Statistical Institute, we may make the attempt to enumerate all the nests of some conspicuous species, such as vultures, night herons, and cattle egrets, in an area of ten square miles or so. When this has been done for thirty or so representative areas in India we shall be in a position to estimate, no doubt very roughly, the total population of these species in India.

The total numbers of breeding adults of a few local species are roughly known (see Fisher and Lockley 1954). Thus for the gannet, *Sula bassana*, the number of nests in the East Atlantic area (Britain, etc.) was about 70,000 in 1939 and had risen to 82,000 in 1949. In the West Atlantic (Newfoundland, etc.) it was about 13,000 in 1939. Thus at present there are about two lakhs of mated birds, and perhaps as many juveniles. They live on a small number of precipitous rocks, mostly on small islands. There are fifteen 'cities' of 17,000 to 1200 nests, and fourteen 'villages' of 500 nests or fewer. These numbers are fairly accurately known. James Fisher had counted thousands of nests on cliffs from small boats. He was able to induce the British Naval Air Force (Fleet Air Arm) to photograph many of these sites as part of their training. The exact numbers of nests could be counted at leisure from the photographs, and the results compared with those obtained by cheaper methods. Few of the latter were incorrect by ten per cent.

This 'urbanization' is characteristic of sea birds, and is carried to greater lengths in more numerous species. The extreme example is furnished by *Uria lomvia*, Brünnich's Guillemot, of which there appear to be four or five million on the coasts of Greenland, about half of which breed on a single rock Agpar-s-suit. This is one extreme of bird behaviour. Most small song birds keep a "territory" round their nests private by singing and quarrelling with intruders, even if they are more sociable when not breeding, while others, such as the Indian weaver bird, live in 'villages' of a few tens or hundreds of nests.

Is there any possibility of counting all the breeding members of an Indian bird species? I suggest that the most hopeful targets are the large flamingo *Phoenicopterus antiquorum*, and the smaller species *Phoeniconaias minor*. The former breeds in the Great Rann of Kutch and the latter possibly in the Little Rann. The Lesser Flamingo, which lives on unicellular algae, is not apparently found in many other localities except Sambhar Lake in Rajasthan. The Rann of Kutch is unsuitable for walking but, owing to the absence of trees, it should be possible to photograph nesting birds from the air. This can of course only be done by the Indian Air Force. In peace time the armed forces have to carry out exercises of various kinds. Their efficiency can be better gauged from their performance against natural forces, for example the rapid replacement of bridges destroyed by floods, or the landing on a difficult coast, than by their prowess against 'enemies' who they know will not hurt them. Hence such co-operation would, I believe, increase the efficiency of our Air Force.

So much for mere populations or densities per square mile. But how do these increase or decrease? Observations on a few hundred or even a few dozen nests of any species will tell us the average number of eggs laid per year. More careful, but not very arduous, watching will tell us how many young birds per nest survive to start flight. On the whole tropical birds produce fewer eggs in a clutch than birds of the same species or a closely related species in a temperate climate. This is at least partly due to the shorter tropical days, which do not give the parents time to feed a large brood. Most of the comparisons have been made by Moreau with African birds, but Lack (1950) points out that in India *Parus major* (the Great Tit) has an average clutch of 3 compared with 10 in England. This difference must be compensated in one of two ways. Either the average number of clutches in India must be greater or the mortality less. There must be a balance because if, for example, the numbers in an area increased by only 10% per year for a century, the density would increase 13,781 times. This can of course happen when a new species occupies a country, but not with established species. In only one case has this balance been directly demonstrated by comparison of statistics. In Switzerland the Starling (*Sturnus vulgaris*, a bird very similar to the myna) lays more eggs than in England, but dies younger. It will be easy to get data on numbers of broods in India, not so easy to get data on mortality. Before I speak about mortality, let me say a few words on the feeding of young.

What do they get to eat? One can of course kill parents and examine their crop contents. Apart from ethical considerations this means that one can only get one piece of information from a bird. Several other methods are available. Lack found that if he caught parent swifts (*Apus apus*) they might desert their young. So he waited until a parent bird fed a baby and departed, and then pressed the baby's throat, getting a pellet containing about 600 insects entangled in the parent's sticky saliva. They were largely flying aphids, so swifts eat insects which compete with men for food plants, and what is more, eat them while they are moving to new food plants and invulnerable to sprays and other insecticides. Thus swifts seem to be wholly favourable to agriculture, whereas some other bird species live largely on seeds and lower agricultural output, while other insect eating birds eat some insects, such as bees, which assist in the pollination of plants and thus help human horticulture and even agriculture. We should certainly encourage the birds which are helpful to man, even if we do not massacre the others. A second non-violent method has been used in the Soviet Union. The nestlings are replaced by models which, when a watcher pulls a string, open mouths and may emit a suitable noise. The food falls into a bag, and I hope is given to its legitimate owners after the insects, molluscs, seeds, and so on, have been assigned to their correct species.

Do young birds get enough to eat? Lack (1954) found that when the brood size was less than the average, the number of young starlings surviving for a few months was roughly proportional to the brood size. However this was not so when the brood size exceeded the average. Even if the excess young survived to fly, they did not survive much longer. Presumably their parents could give them enough food to fledge, but not enough to get an adequate start in life. The technique consists of ringing nestlings. But of 15,000 starlings ringed in this research, only 346 or 2.3% were recovered, that is to say found dead and the rings returned.

The ringing technique was invented by Mortensen in Denmark to study migration. As you know, several ducks ringed in India have been picked up in Siberia and vice versa, and one German-ringed stork in India. Ringing birds does not harm them. One ringed robin (*Erithacus rubecula*) in Eire lived for eleven years, though nearly two-thirds of all robins die each year, so only about one robin per lakh is expected to live so long. It is a fortunate and peculiar fact that birds' legs are fully grown before they start flying. A metal or plastic ring can therefore be put on a nestling and remain on its leg for life. The rings usually carry a request to send them to a certain address if found. There may be a small reward. In Western Europe population density and literacy are both so high that as many as 15% of the rings on large birds are returned. We cannot yet hope for such good results in India. But we may reach them when our children are educated.

Table I gives data on *Vanellus vanellus,* the lapwing, a British crested bird of about the size of the hoopoe, and which our great British naturalist William Turner thought to be a hoopoe four hundred years ago, since ancient authors of about two thousand years ago had described only one crested bird of this size. Then he went to Central Europe and saw a hoopoe, which agreed very well with the Latin description. He realised that there were birds in Britain of which the ancients knew nothing, and started to describe them. That was the beginning of scientific ornithology in Britain.

Each ring is recorded on a card in an office at the British Museum of Natural History in London, and I analysed all the cards recording rings put on nestling birds before the year 1940 (Haldane 1955). I made the table in 1954, so, as one bird had lived for fourteen years, if I had included birds ringed, say, in 1950, many would still have been alive. Following a method due to Lack, I omitted all birds picked up in the same year when they were ringed. Their number is large, but it is misleading because a man who has taken the trouble to ring fifty little lapwings will probably notice dead ones in his neighbourhood, and hence the apparent mortality in the first eight months will be too high (Table I). The first column is the year of the bird's life in which it was

TABLE I

| $x$ | $d_x$ | $xd_x$ | $\mathfrak{S}(d_x)$ | $\Delta$ | $\chi^2$ |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |
| 1 | 194 | 194 | 206.38 | −12.38 | 0.74 |
| 2 | 145 | 290 | 136.21 | + 8.79 | 0.57 |
| 3 | 90 | 270 | 89.90 | + 0.10 | 0.00 |
| 4 | 54 | 216 | 59.33 | − 5.33 | 0.48 |
| 5 | 48 | 240 | 39.16 | + 8.84 | 2.00 |
| 6 | 25 | 150 | 25.85 | − 0.85 | 0.03 |
| 7 | 24 | 168 | 17.06 | + 6.94 | 2.82 |
| 8 | 9 | 72 | 11.25 | − 2.25 | 0.45 |
| 9 | 6 | 54 | 7.43 | − 1.43 | 0.28 |
| 10 | 5 | 50 | 4.90 | + 0.10 | 0.00 |
| 11 | { 5 | 55 | { | | |
| 12 | 7 { 1 | 12 | { | | |
| 13 | { 0 | 0 | { 9.53 | − 2.53 | 0.67 |
| 14 | { 1 | 14 | { | | |
| | 607 | 1785 | 607.00 | 0.00 | 8.04 |

picked up. Thus if a bird was ringed in 1930 and found dead in 1931 we say that its age $x=1$. $d_x$ is the number of birds found dead in the $x$th year of their life. For example 54 rings were from birds dying in their fourth year (e.g. birds ringed in 1940 and picked up in 1944). The third column is the product of the first two. Now suppose that in each year a constant fraction $m$ of all birds dies, we find that 607/1785 (the ratio of the totals of columns 2 and 3) gives us an estimate of $m$, namely .340 or 34.0%. Now this seems a very simple theory, too simple to be true, for we know that in human beings a bigger fraction die in their sixtieth year than their sixth, in other words $m$ is not constant. If $m$ is constant we expect that 607 $m$, or 206.38, birds died in their first year, leaving 400.62, and 400.62 $m$, or 136.21, died in their second year. In this way the expectations in column 4 were calculated. Column 5 gives the differences of columns 3 and 4. If $m$ increased with age, as in man, the values would at first be positive, and later negative. We can make a further test. Dividing $\Delta^2$ by $\mathfrak{S}(d_x)$ we get the last column. If $m$ is constant we should expect the total to be 9; it is rather less. There is no reason to doubt the constancy of the mortality. In other words all birds after their first year died of accident. There is no evidence that any small bird dies of old age in nature, for other species have yielded similar results. I dealt in a similar way with the figures for 120 birds ringed from 1940 to 1951. The mathematics are much more complicated, and give $m$=.372, which is close enough to the former value to give me some confidence in my calculations. The annual mortalities range from about two-thirds for very small song birds to about a tenth or less for large sea birds. But in some ways the results obtained about migration are even more interesting. Dr. Sálim Ali tells me that systematic work is at last being started to map out migration routes between India and Siberia.

How do bird populations change? This could be studied in India as easily as anywhere else. When a species is introduced into a new habitat it may increase very quickly. Figure 1 shows the rate of increase of *Phasianus colchicus* on an island off the American coast. Four pairs were introduced. The biennial census shows the effect of juvenile mortality. The population increased from two to four times annually, and showed some signs of stabilizing, until a very formidable predator, the American soldier, was introduced, and further observations were useless. But the population had increased from 8 to 1325 in five years. Figure 2 of *Parus major* in a British wood is more typical. The increase was due to the installation of nesting boxes. The population increased violently each spring and fell back in autumn. Some birds left the wood each winter, and they or others returned before the nesting season. Similar observations could be made in India, even on the same species.

If there are enough ornithologists in India ten years hence we shall be able to begin observations like those recorded in Fig. 3, which gives the population of herons (*Ardea cinerea*) at a number of

English nesting sites. A very cold winter, such as that of 1947, reduced the number of birds, probably because a great deal of water was frozen. But they regained their original density in two years or so, and showed no tendency to increase indefinitely. If we knew how

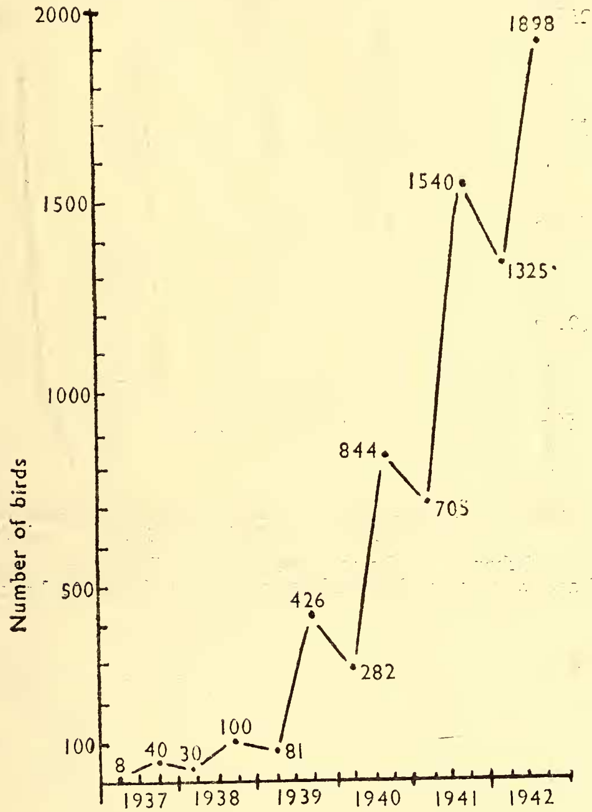


Fig. 1. Increase of pheasants (*Phasianus colchicus*) on Protection Island, Washington, U.S.A. After Einarsen and Lack (1954).

they achieved this stability we human beings might take some hints from them. It seems likely that marriage is postponed where there is a shortage of nesting sites. Other bird populations, especially in northern regions, show cyclical fluctuations with a period of about ten years, but the figures are not very satisfactory.

Such investigations take some time; Dr Sálim Ali may wish me to suggest topics which would give results in a year or two, and thus secure a M.Sc. Bird behaviour offers many such possibilities. One of our English song birds, the thrush (*Turdus ericetorum*), leaves a record of its predations, as it breaks snail shells on stones or tree stumps before giving their contents to its young. Table II is a record

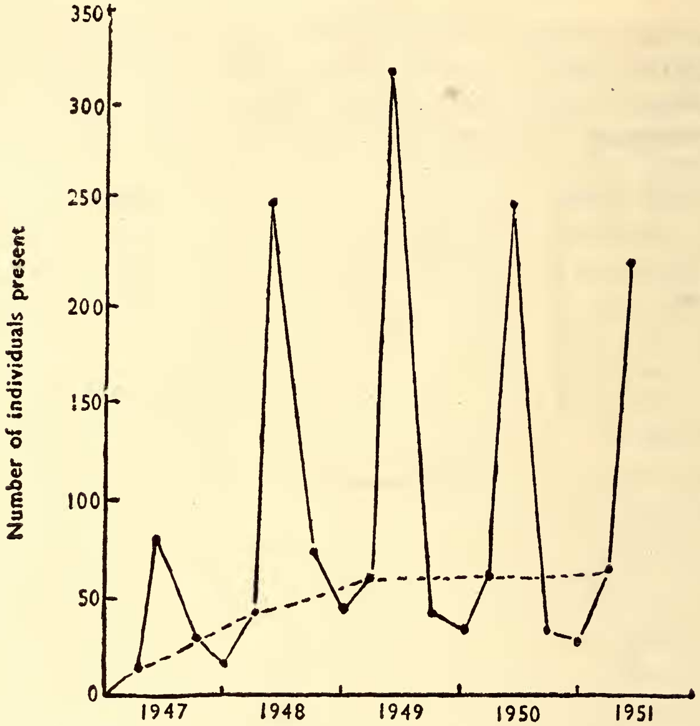


Fig. 2. Seasonal changes in the numbers of Great Tits (*Parus major*) in a 63 acre wood near Oxford, England. After Gibb and Lack (1954).

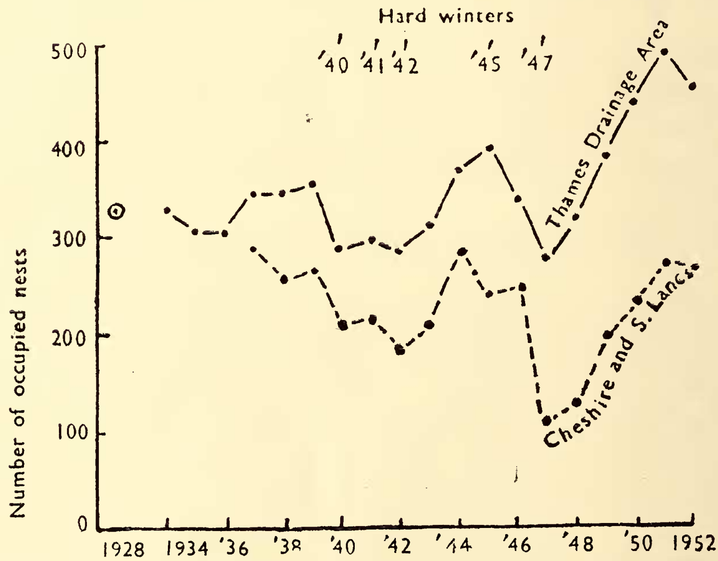


Fig. 3. Breeding Populations of Herons (*Ardea cinerea*) in two areas of England. After Lack (1954).
The 'hard' winters are those in which water was frozen for long periods, rendering fishing difficult.

of its behaviour. The snail species *Cepea nemoralis* has several colour forms, which can be classified as yellow and not yellow, the former being recessive. On a brown background of dead leaves the yellow snails are conspicuous to the human eye, while they are less conspicuous among green leaves. They are also commoner on green backgrounds such as grass which does not dry up in summer, than on

TABLE II

Snails *Cepea nemoralis*, collected by men and killed by thrushes in Marley Wood, near Oxford

Data of P. Sheppard

| Date | Yellow | Not Yellow | % Yellow | .. |
|---|---|---|---|---|
| 14. 4. 50 | 80 | 250 | 24·2 | Human collections |
| 26. 5. 50 | 57 | 147 | 27·9 | |
| 6 to 11. 4. 50 | 3 | 4 | 43 | Killed by *Turdus ericetorum* |
| -23. 4. 50 | 7 | 10 | 41 | |
| -30. 4. 50 | 11 | 21 | 34 | |
| - 7. 5. 50 | 9 | 25 | 26 | |
| -19. 5. 50 | 3 | 16 | 16 | |
| -22. 5. 50 | 1 | 6 | 14 | |
| -26. 5. 50 | 2 | 12 | 14 | |
| 6. 4. 50 to 26. 5. 50 | 36 | 94 | 27.7 | Total bird-killed |

brown ones such as the floor of beech woods. Sheppard (1951) made counts of snails killed by thrushes during the breeding season of 1950 in a wood where there were few green leaves in early April, and many in late May. We see that the thrushes collected more of the snails which were conspicuous to the human eye at the times in question. But their overall bag favoured neither type of snail, so it looks as if they were responsible for keeping the observed proportion of yellow snails. This is an example of Natural Selection in action. Similarly Kettlewell (1956) has shown how birds act as agents of natural selection in transforming the colour of the moth *Biston betularia*. I have little doubt that similar studies of choice by birds in nature could be made in India. My colleague Sri K. R. Dronamraju is now making one at Calcutta, but in his case the choosers are butterflies, not birds.

Here is another example of bird behaviour which could and should be studied statistically. Moreau, Purchon, and others, in a series of papers in the *Proceedings of the Zoological Society of London*, have studied the visits of birds, both in Africa and Europe, to their nests when brooding eggs and feeding their young. Unfortunately they never give all the figures needed for a complete statistical analysis. It is however clear that in several species the time spent on the nest per day rose during incubation, and then fell again as the young demanded more and more food but less and less warmth. The durations of absences were less variable than those of stays on the nest. This can be interpreted as meaning that the parent bird has a strong urge to return after five minutes or so, even if it has found little food, and no strong urge to leave the nest after a standard time. However, it would be most valuable to collect such data in such a way that they could be given adequate statistical treatment. This would mean observation throughout the hours of daylight during a nesting period, which would require the co-operation of at least two men. Moreau however was very satisfied by the performances of illiterate African assistants, and I have no doubt that equally reliable Indians are available. If the data are complete, the Indian Statistical Institute can analyse them.

I am not musical, and cannot detect slight difference in bird songs and calls. Their full investigation demands the rather expensive apparatus used by Thorpe (1955). But this is not essential. Marler (1952) wandered about Britain with no apparatus beyond two ears and a note-book, and found differences in the song of the same species, *Fringilla coelebs*, in five different areas. He also studied it in the Azores islands, while Promptoff had previously done so in two areas of the Soviet Union. The differences were quite marked. The most complicated song, on an average, was sung in Scotland. But the birds of the Thames Valley were more variable, and included the finest songsters. In the Azores where there is no other species with a similar song, and therefore no biological need for a species-specific song, the performance was much simpler and cruder. Similar work could and should be done in India. Are there, for example, Marathi and Gujarati songs in the same bird species?!

From a cursory reading of Tinbergen's (1951) work you might think that birds respond to very crude stimuli. Like men they sometimes do so, but not always. Migratory birds have definite routes which generally avoid long ocean and desert crossings, and often follow coast lines and large rivers. In Scandinavia and Germany most small song birds which winter in tropical Africa follow the Atlantic coast. But *Sylvia curruca*, the Lesser Whitethroat, flies southeast from Germany to Turkey, and then south along the Nile

Valley. They mainly fly at night, and birds in their first year can find the way. How do they 'know' it? I end up by introducing you to one of the most amazing stories in the whole of biology, a story which I hope, but am not certain, is true, though I have the greatest respect for its author. But scientists are human, and even the greatest of them make mistakes. Sauer hatched birds in the laboratory and kept them in cages where they never saw the sky. They became restless at night for two or three weeks at the normal migration times in autumn and spring. If they can see even a part of the sky, they attempt to fly approximately southeast.

Now comes Sauer's (1958) amazing discovery. The birds responded perfectly well in a planetarium, that is to say a dome in which the stars are represented by points of light. Now in such a planetarium we can alter the apparent position of the stars in two ways. We can alter them as they would alter at the same place during one night. For example in Germany in late October Rohini (Aldebaran) was well up in the sky when the stars were first seen after sunset, while Kalpurush (Orion) was just rising. If the planetarium was arranged to show the stars in this position the birds tried to fly southeastwards, as they should. Now the planetarium was altered so that Kalpurush was high in the sky, and Sinha (Leo) rising, in fact the stars as they would be seen about 11 p.m. The birds tried to fly westwards. Now at that moment they would have seen the stars in those positions if they had been near lake Balkhash in Kazakhstan, and their best way to western Turkey would have been to fly west. At intermediate star positions they flew southwest and south. The pole of the planetarium can also be shifted so that the stars appear as they would from another latitude. Sauer changed the apparent position of the stars to that which would be seen at the same time in Egypt. Achernar was shown in the south, the Saptarshi (Ursa Major) were below the northern horizon. The birds flew south, as they would have done in Egypt.

Of course I have over-simplified Sauer's account. Perhaps Matthews's results on solar navigation are equally remarkable, though they are still not universally accepted. But it does appear that some birds have, if not an innate knowledge of astronomy, at least an innate capacity for responding to certain star patterns. Presumably some kind of pattern develops in their brain which corresponds to that of the stars, as of course feather patterns develop on their skins. Probably Matthews's work will be easier to repeat in India, but somehow Sauer's seems to me more exciting, if only because it suggests that birds may have knowledge which has not come to them through their senses. And if birds, why not man?

I must apologize to Dr Sálim Ali for the numerous inaccuracies which I am sure have crept into this lecture. But this is inevitable if I am lured into speaking on a subject to which I have made no serious contributions. I close with the hope that in his old age he may be able to introduce scientific ornithology, to which he has made such notable contributions, into the curriculum of our universities.

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